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(12) UK Patent Application (19) GB (11) 2 158 001 A

(43) Application published 6 Nov 1985

(21) Application No 8411543

(22) Date of filing 4 May 1984

(51) INT CL[4]
B29C 41/08

(52) Domestic classification
B5A 1R137 1R165 1R214F 1R314C2B 1R314C2S 1R400 2E6 2L T12P
U1S 1417 1820 1946 B5A

(56) Documents cited
GB 1312019
GB 0815630
GB 0767515
GB 0723724

(58) Field of search
B5A

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(54) A moulding for inserting into an exhaust silencer casing

(57) A strand of fibres of a suitable silencing material, eg basalt, glass or ceramic, is chopped into discrete lengths by passing it between two rollers one of which carries a cutter. The chopped roving is carried in an air flow, established by an air blast, air jet or a vacuum, into a mould (1). The fibres may "fluff-up" into a wool-like consistency as they pass into the mould (1). A bonding agent is introduced into the mould (1) to bond the fibres into a unitary body which can, after curing, then be removed from the mould (1) for insertion into an exhaust silencer casing.

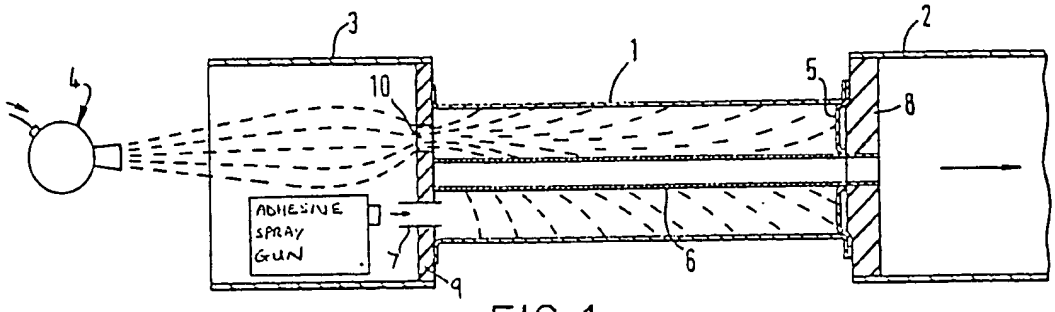

FIG. 1.

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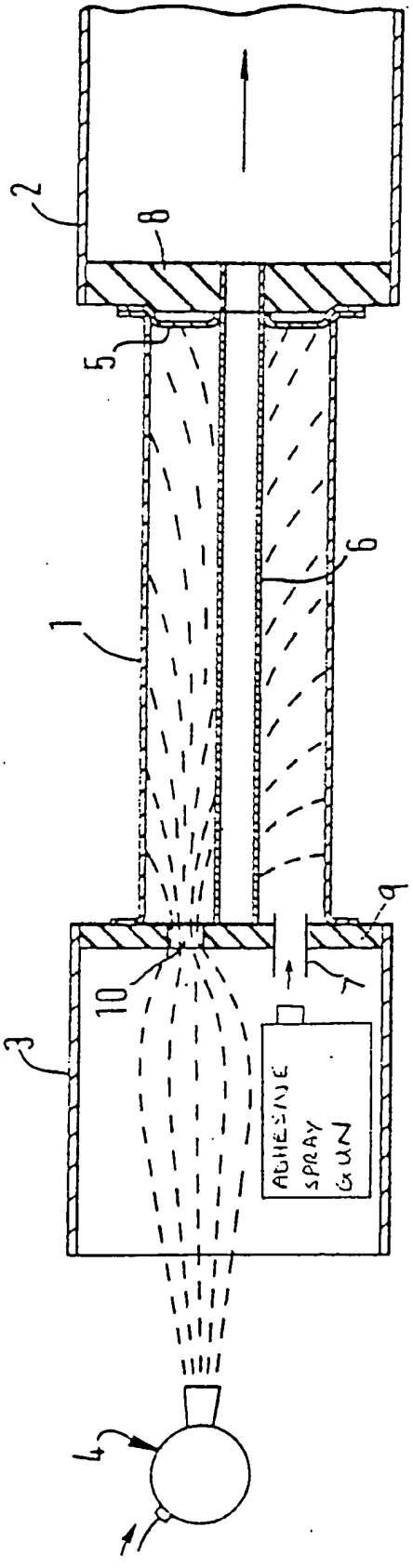

FIG. 1.

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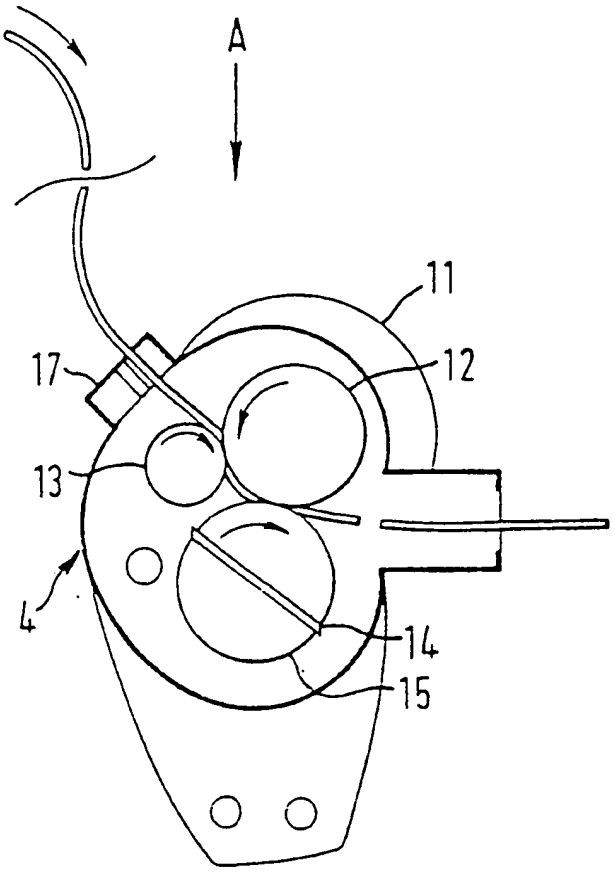

FIG. 2

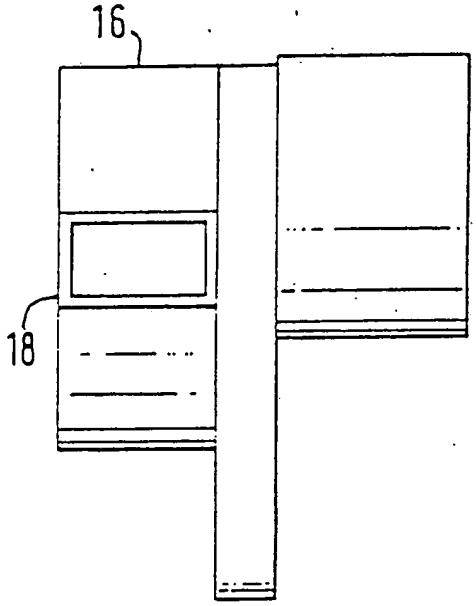

FIG. 3

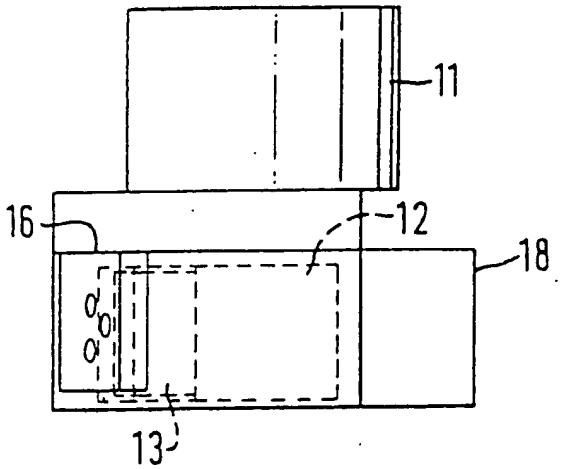

FIG. 4

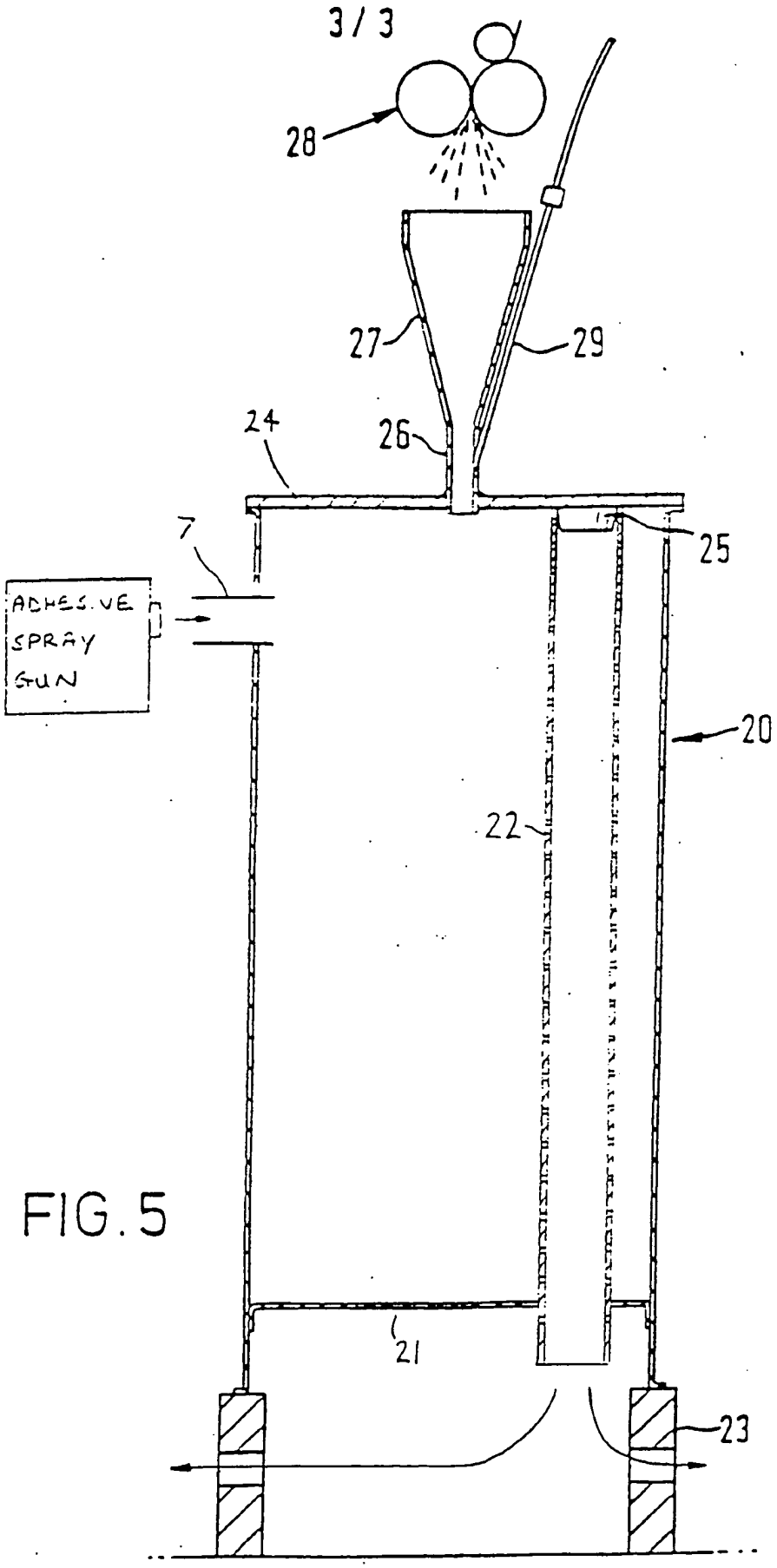

FIG.5

SPECIFICATION

Method and apparatus for making a moulding for inserting into an exhaust silencer casing

This invention relates to a method and apparatus for making a moulding for inserting into an exhaust silencer casing.

Exhaust silencer casings contain packing in order to assist in silencing exhaust gases from an engine by virtue of conversion of kinetic energy of the exhaust gases into mechanical displacements of the packing and thus heating thereof. The packing preferably comprises fibres "fluffed-up"into a wool-like consistency. This material can be produced by chopping continuous strands of a suitable fibre. In the past silencer casings have been packed manually and, to assist in this process, it has been proposed to apply a vacuum to one end of the silencer casing. In order to adapt the process for automatic operation, fibre material in wool-like form has been fed into a hopper, from which it passes along ducts before being metered into individual quantities, each suitable for packing one silencer casing. However the material has been prone to clog in the ducts and this has made the accurate metering of the material difficult, if the expense of weigh pans is to be avoided.

According to a first aspect of this invention there is provided a method of making a moulding for inserting into an exhaust silencer casing comprising the steps of: establishing gas flow through a mould having a shape corresponding to that of the moulding to be formed; chopping a strand of fibres into discrete lengths; allowing the chopped fibres to be carried into the mould in the gas flow; introducing a bonding agent into the mould to bond the fibres into a unitary body; and removing the moulding thereby formed from the mould. A moulding is thus formed which can be inserted into an exhaust silencer casing to provide the desired packing.

According to a second aspect of this invention there is provided apparatus for making a moulding for inserting into an exhaust silencer casing comprising: a mould having a shape corresponding to that of the moulding to be formed; means for establishing gas flow into the mould, means for chopping into discrete lengths a strand consisting of fibres and for introducing the chopped strands into the gas flow; and means for introducing a bonding agent into the mould.

Preferred features of this invention will be apparent from the subsidiary claims of this specification.

It should be noted that the term "strand" used in this specification refers to a plurality of fibres which may be twisted, plaited or laid parallel. A strand typically comprises 200 - 1600 fibres. The term "roving refers to a bundle of strands. A roving typically comprises eight or more strands and may comprise over 500 fibres. The term "fibre" refers to an elongate object, such as a filament, from which a wool-like material can be made. It has been found that the individual fibres of each discrete length of chopped strand separate as they are carried into the mould in the gas flow so that the fibres "fluff-up" in the desired manner in the mould itself or as they enter the mould. These fibres can then be bonded together into a unitary body by introducing a bonding agent into the mould. The moulding can then be withdrawn from the mould and used as an insert for an exhaust silencer casing.

Alternatively, chopped fibres can be injected into the mould along with a bonding agent so that the fibres are bonded together to form a unitary body before they are able to "fluff up".

This invention will now be illustrated, merely by way of example, with reference to the accompanying drawings, in which:

Figure 1 is part sectional view of a first embodiment of apparatus used in a method according to this invention;

Figure 2 is a side view of a gun of the apparatus shown in Figure 1;

Figure 3 is a front view of the gun shown in Figure 2;

Figure 4 is a plan view of the gun shown in Figure 2; and

Figure 5 is a schematic view of a second embodiment of apparatus used in a method according to this invention.

The apparatus shown in Figure 1 comprises vacuum producing apparatus 2, sealing apparatus 3 and a gun 4 for introducing chopped fibre into a mould 1.

The mould 1 is circular in cross-section, and one end thereof is closed by an end piece 5 which supports a perforated tube 6 extending through the mould 1. The illustrated mould has a shape corresponding to that of a silencer casing (not shown) into which the moulding formed is to be inserted.

The vacuum producing apparatus 2 has a rubber sealing member 8 which fits tightly around an end of the tube 6. A vacuum is produced in the apparatus by means of a centrifugal compressor (not shown) driven by a forty horse power (29.8 KW) motor (not shown). This produces a vacuum of around ten inches of mercury (33.9 KNm^{-2}) in the apparatus 2.

The sealing apparatus 3 likewise has a sealing member 9 and this seals against the open end of the moulding 1 and also blocks off the open end of the perforated tube 6, as the tube 6 should not be filled with any packing material. The sealing member 9 includes a circular aperture 10 whose diameter is 3/4 inch (19mm) which provides communication between the interior of the sealing apparatus 3 and the interior of the mould 1. The aperture 10 forms a restriction in the pathway from the gun 4 to the interior of the mould 1. A nozzle 7 is provided for introducing a bonding agent or adhesive into the mould 1, preferably a heat curing adhesive. A low viscosity adhesive, such as a water-based sodium silicate adhesive, is

injected through the nozzle 7 from a compressed spray gun. If a two part adhesive is used, the gun may spray both components into the nozzle where they can mix with each other. The nozzle 7 can be positioned at any point in the mould 1 but should preferably be spaced from the aperture 10 so that the chopped fibres "fluff up" before being coated with adhesive. Some, or indeed much, of the injected adhesive may pass through the mould 1 and it is therefore desirable to provide a filter (not shown) in the vacuum producing apparatus 2 to prevent it from becoming clogged. In a preferred arrangement, adhesive which passes through the mould 1 is recycled to the spray gun or to the nozzle 7.

Alternatively, the fibres and adhesive could be injected together into the open end of the mould so that the fibres are bonded together in a non-"fluffed-up" form.

Figure 2 shows roving being fed into the gun 4 and discrete lengths of this being emitted from the gun 4. The roving consists of a bundle of strands each of which consists of a plurality of glass fibres, eg at least 100 or at least 1000 fibres Other types of fibres which when "fluffed-up" form a wool-like material may be used, for instance ceramic fibres or fibres formed of a mineral such as basalt, ie the material from which rockwool is made. The fibres typically have a diameter in the range of 6-12 microns. The fibres in each strand may be twisted , plainted or laid parallel and the fibres may be continuous,ie extend the length of the strand, or may be relatively short in which case they may be spun to form a strand in much the same manner as cotton or wool is spun to form threads. Preferably, the roving fed into the gun 4 comprises eight or more strands so that each discrete chopped length thereof consists of a large number of fibres, eg over 2000 fibres. However, it is possible to operate the apparatus with only a single strand being fed into the gun 4. Preferably, the fibres have a diameter of less than 30 microns or less than 15 microns. The roving is fed into the gun 4 from a spool (not shown) containing a length of about two hundred meters of roving.

The gun 4 has an air-powered motor, contained in a housing 11, to which a rubber roller 12 is coaxially attached. The roving is driven through the gun 4 by means of the rubber roller 12 and a steel roller 13 which is hard in contact with the rubber roller 12. The roving is cut into discrete lengths by means of a cutter 14 mounted diametrically through a further roller 15 so that the cutter 14 extends along a generator of the roller 15. Every half revolution of roller 15, the roving is severed at the point of contact between the rollers 12 and 15. The rollers 12, 13 and 15 are contained in a housing 16 (see Figures 3 and 4) having an inlet 17 and an outlet 18. Exhaust air from the air powered motor is fed into the housing 16 and, since the area of the outlet 18 is much greater than that of the inlet 17, the chopped lengths of roving are projected out of the gun 4 with the aid of a blast of this exhaust air.

In operation, a mould 1 to be filled with packing is fitted onto the vacuum producing apparatus 2 and the sealing apparatus 3 is brought up to the open end of the mould 1. The centrifugal compressor is started. The gun 4 is then run and left running for a pre-determined period of time. This pre-determined period corresponds to the desired weight of the moulding to be formed and this can be calculated simply from the weight per unit length of the roving and the velocity at which the roving is fed through the gun 4. The bonding agent is introduced into the mould 1 through the nozzle 7 as the mould 1 is being filled with fibres.

The chopped lengths of roving projected from the gun 4 are all sucked through the aperture 10 in the sealing member 9 by the vacuum applied at the other end of the mould 1, and the mould 1 is gradually filled with fibres. It has been found that the fibres in each chopped length of roving separate either before they enter the mould 1 or while they are in the mould 1 (probably the separation mainly takes place within the mould), and this results in the production of the desired wool-like form of the fibres in the mould 1. The air flow within the mould 1 will of course be turbulent since it is being sucked through the perforated tube 6. The fibres do not pass into the tube 6 themselves. The bonding agent bonds the fibres in the wool-like form into a unitary body. When sufficient fibre has been packed into the mould, the mould 1 is heated to promote curing of the bonding agent. Heaters may be provided in the walls of the mould for this purpose. When the bonding agent has cured, the moulding thus formed is withdrawn from the mould. The moulding is semi-rigid and which can be simply inserted into an exhaust silencer casing.

One advantage of the apparatus and method described is that it is possible to accurately meter the quantity of fibres making up the moulding. Also, the ducting required for handling wool-like fibre is not required.

Various modifications of the described apparatus are of course possible. For example, tests have been carried out with an arcuate aperture 10 in the sealing member 9, the aperture 10 having length of about four times its breadth. Although the roving "fluffed-up" in a satisfactory manner, it was nevertheless found that it "fluffed-up" better with the 3/4 inch (19 mm) diameter aperture referred to earlier.

The apparatus shown in Figure 5 differs from that shown in the previous figures in that no vacuum is required to draw the chopped roving into the mould. Instead, the chopped roving is carried into the mould by an air flow.

A mould 20 to be filled with packing is closed at the lower end as seen in Figure 5 by a closing plate 21 which has an aperture through which a perforated tube 22 extends. The mould 20 is mounted on a platform 23 through which air can pass. At the upper end of the mould 20 as seen in the Figure is a closing plate 24 which carries a plug 25 for closing the upper end of the perforated tube 22.

Chopped strands of roving are fed into the mould 20 via a tube 26 and a conical member 27, the tube

26 being sealed in an aperture in the closing plate 24. The tube 26 thus forms a restriction in the pathway from a gun 28 to the interior of the mould 20.

The gun 28 supplies chopped roving to the wide end of the conical member 27. The gun 28 is similar to the gun 4 described above except that the exhaust air thereof does not assist in projecting the chopped strands of roving from the gun 28, the chopped roving being projected from he gun 28 solely by the rotation of the rollers 12, 13 and 15.

A narrow tube 29 opens into the tube 26, and compressed air is supplied through the narrow tube 29 into the tube 26. It has been found that the compressed air fed into the tube 26 draws large quantities of air into the conical member 27, through the wide end thereof and hence through the tube 26 into the mould 20. The chopped roving is therefore carried by this air flow into the mould 20. The air flow leaves the mould 20 via the perforated tube 22. As in the apparatus described above, in a preferred arrangement, any adhesive carried through the mould and out of the tube 22 is preferably recycled to the spray gun or nozzle 7. It has been found that the fibres of the chopped roving are "fluffed-up" in this process, and that the mould 20 is filled in a very satisfactory manner. The bonding agent is introduced into the mould 20 through the nozzle 7 as previously described for the apparatus shown in Figure 1.

Examples of suitable dimensions and pressures for the apparatus shown in Figure 5 will now be given.

Length of tube 26	3 inches (76.2 mm)
Diameter of tube 26	1/2 inch (12.7 mm)
Semi-angle of conical member 27	30°
Diameter of wide end of conical member 27	3 inches (76.2 mm)
Angle between tubes 29 and 26	35°
Pressure of compressed air in tube 29	100 lbs ins $^{-2}$ (689.5 KNm^{-2})

It is believed that the narrow diameter of the tube 26 is important in "fluffing-up" the chopped roving, since only with a narrow diameter is sufficient turbulence created in the tube 26 to achieve this. Similarly, it is believed that the narrow aperture 10 in the apparatus shown in Figure 1 is responsible for creating the necessary turbulence to cause "fluffing-up". The narrower the diameter of the tube 26 or aperture 10, the smaller the compressed air pressure or vacuum needed to "fluff-up" the chopped roving. However, if the diameter is too small, the restriction is prone to clogging.

It will be apparent that any means of establishing an air flow or gas flow through the mould to be packed may be used to carry the chopped roving into the casing.

The bonding agent introduced preferably accounts for less than 5% of the weight of the moulding and may account for about 3% of the weight of the moulding. Bonding agents such as polyvinylacetate (PVA), sodium silicate and phenolic resin may be used.

The moulding formed may be of a shape corresponding to the exhaust silencer casing into which it is to be inserted. In this case the mould used to form the moulding would have a shape very similar to the exhaust silencer casing. Alternatively, the moulding may, for instance, be cylindrical or rod-shaped. A plurality of such mouldings could then be used to pack each exhasut silencer casing and casings of different shapes could be packed by the same mouldings.

This invention also relates to a moulding produced by the methods described above.

CLAIMS

1. A method of making a moulding for inserting into an exhaust silencer casing comprising the steps of: establishing gas flow through a mould having a shape corresponding to that of the moulding to be formed; chopping a strand of fibres into discrete lengths; allowing the chopped fibres to be carried into the mould in the gas flow; introducing a bonding agent into the mould to bond the fibres into a unitary body; and removing the moulding thereby formed from the mould.

2. A method as claimed in claim 1 in which the mould is heated to promote curing of the bonding agent prior to removal of the moulding.

3. A method as claimed in claim 1 or 2 in which the bonding agent is introduced in a quantity such that it comprises less than 5% by weight of the moulding produced.

4. A method as claimed in claim 3 in which the bonding agent is introduced in a quantity such that it comrpises substantially 3% by weight of the moulding produced.

5. A method as claimed in any preceding claim, in which the strand consists of at least one hundred fibres.

6. A method as claimed in claim 5, in which the strand consists of at least a thousand fibres.

7. A method as claimed in any preceding claim in which the diameter of the fibres is less than thirty microns.

8. A method as claimed in claim 7, in which the diameter of the fibres is less than fifteen microns.

9. A method as claimed in any any preceding claim in which the strand is fed between two rollers engaging one another, one of which is driven.

10. A method as claimed in claim 9, in which one of the rollers has a cutter extending along a generator thereof.

11. A method as claimed in any preceding claim in which the gas flow leaves the mould via a perforated tube which extends therethrough.

12. A method as claimed in any preceding claim, in which the gas flow carries the chopped fibres through a restriction, the breadth of which is less than one inch (25.4 mm), before they enter the mould.

13. A method as caimed in any preceding claim in which the moulding is subsequently inserted into an exhaust silencer casing having a shape corresponding to that of the mould.

14. A method as claimed in any one of claims 1 to 12 in which a plurality of the mouldings are subsequently packed into a single exhaust silencer casing.

15. A method substantially as hereinbefore described with reference to the accompanying drawings.

16. A moulding produced by a method as claimed in any preceding claim.

17. Apparatus for making a moulding for inserting into an exhaust silencer casing comprising: a mould having a shape corresponding to that of the moulding to be formed; means for establishing gas flow into the mould; means for chopping a strand of fibres into discrete lengths and for introducing the chopped fibres into the gas flow; and means for introducing a bonding agent into the mould.

18. Apparatus for making a moulding for inserting into an exhaust silencer casing substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the UK for HMSO, D8818935, 9/85, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.